2 of 3

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Hexcel Research
Reference 6065

June 16, 1964

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Picatinny Arsenal
Dover, N. J.

Attn: Procurement and Production Directorate
SMUPA - PB1

Subject: Contract No. DA-04-200-AMC-477 (A)
Development and Evaluation of a Lightweight Aluminum Honeycomb Case
Monthly Progress Report #5

Gentlemen:

Enclosed is the report describing the work done on the subject contract during the month of May 1964. The report was prepared by the Advanced Structures Group, Research Division, Hexcel Products, Inc., Berkeley 10, California.

Included as attachments are (1) Statement of Man Hours Expended - May 1964, (2) Schedule showing Current Progress - May 1964, and (3) Schedule showing Program of Ensuing Activities - June and July 1964.

Yours very truly,

E. C. Vicars
Research Director

ECV/jem

Encs.

REPORT OF PROGRESS
MAY 1964

1. DESIGN OF CASE HXL-3-477

The design of the Case was modified using the results of the evaluation of the testing on Case HXL-2-477 which was given in Progress Report #4. The design changes are summarized below:

1.1 The core contact area of the energy absorption cylinder was reduced by making the circumferential core cutouts wider. See Figure 1. The core in the empty rings was cut out instead of being pressed into a thinner layer as in Case HXL-2-477. (Ref. 4.3.2, Progress Report #4).

1.2 The diameter of the energy absorption end caps was increased to the same diameter as the energy absorption cylinder. This was done to provide protection for the hydrostatic cylinder during the edge drop (ref. 4.3.3, Progress Report #4).

1.3 The diameter of the hydrostatic end plates was increased beyond the diameter of the hydrostatic cylinder. This was done to provide support for the energy absorption core in the end caps during the edge drop (ref. 4.3.3, Progress Report #4).

1.4 The inner skin of the hydrostatic end caps was increased from .012 to .016, and two .012 reinforcing doublers were used instead of one as on Case HXL-2-477. (ref. 4.3.1, Progress Report #4).

2. TESTING OF CASE HXL-3-477

2.1 Hydrostatic Pressure Test

The Case was damaged during preparations for the first hydrostatic pressure test. After the Case was repaired, it was decided to postpone the pressure testing until after the vibration and drop tests had been completed. After completion of the drop tests, it was discovered that the drop tests had destroyed the joint seal between the end plate and the hydrostatic cylinder. Thus, the hydrostatic pressure test was not performed.

2.2. Vibration Test

A vibration test was conducted in which the Case was placed with the longitudinal axis in a vertical direction and then vibrated along the longitudinal axis. Peak acceleration values are summarized in Table 1. Severe wrinkling occurred around the circumference of the front and rear end caps and around the circumference of the cylinder near the joint with the rear end cap. The Case was then placed with the longitudinal axis in a horizontal position and vibrated along the vertical axis. Peak acceleration values are summarized in Table 1. Crushing of the core and wrinkling occurred where the fixture supports contacted the Case.

2.3 Drop Testing

Drop tests were performed after the completion of the vibration testing. A summary of the drop testing is given in Table 2. The drops are listed in the sequence in which they were performed.

2.4 Evaluation of Test Results

2.4.1 Longitudinal Axis Vibration Test - The only severe amplification was 50 g's at 135 cps. Since this is nowhere near the resonance frequency of the payload, no problem is anticipated.

2.4.2 Vertical Axis Vibration Test - Accelerometer #1 indicated that there was very little amplification at the end of the payload (equivalent to the free end of a cantilever beam). The highest peak reading on Accelerometer #3 was 58 g's at 128 cps. This peak occurred in a direction at 90^{o} to the direction of vibration. Since this is not near the resonance frequency of the payload, no problem is anticipated. However, two peaks did occur near the payload resonant frequency: 50 g's at 195 cps on Accelerometer #2 and 28 g's at 205 cps on Accelerometer #3. This could cause a very severe amplification with the production payload installed in the Case. No action will be taken to correct this condition until these results are confirmed by testing on future cases.

2.4.3 Rear End Drop Test - The peak decelerations during the rear end drop were much higher than the permissible maximum of 40 g's. This had the following causes:

2.4.3.1 There was no bond between the end cap energy absorption core and the skin of the hydrostatic end plate. The loose core

2.4.3.1 (continued)

caused a rebound action when the end cap contacted the floor, resulting in high peak g's.

2.4.3.2 The air sealed in the end cap experienced a sudden compression as the cap contacted the floor. As the dropping action continued, the volume of air was compressed further until the skin cracked, permitting the air to escape. During this short period of time, the compressed air caused a rebound action, resulting in high peak g's.

2.4.4 Flat Drop Tests

The drops in Positions #1 and #2 both resulted in peak g's higher than the permissible maximum of 27 g's. The reasons for the high peak g's in the Position #1 drop were, first, that the rear end cap, already crushed during the end drop test, contributed a high edgewise compression resistance. This explanation was proven by removing the rear end cap before conducting the drop in Position #2. This second flat drop resulted in much lower peak g values. Secondly, The circumferential cuts in the energy absorption cylinder core were not in agreement with the design. As shown in Figure 1, the solid sections of the core were all supposed to be 4" wide, but the actual widths were greater than 4", thus giving more contact area than was desired. This greater contact area also caused the peak g's in the Position #2 drop to be higher than the required minimum.

2.4.4 (continued)

It was noted that the first peaks in both Position #1 and #2 drops were less than the highest peak values. This resulted from the fact that the depth of the circumferential cutouts were approximately 1/2" less than the depth specified in the design. Thus, as the core continued to crush after the first impact, the core over the cutout areas was pushed inward to fill the gaps. This resulted in a greater core contact area with resulting higher peak values.

2.4.5 Edge Drop Test

A maximum peak of 30.8 g's was obtained. This is higher than the required maximum of 27 g's and was caused by lack of sufficient depth of energy absorption core.

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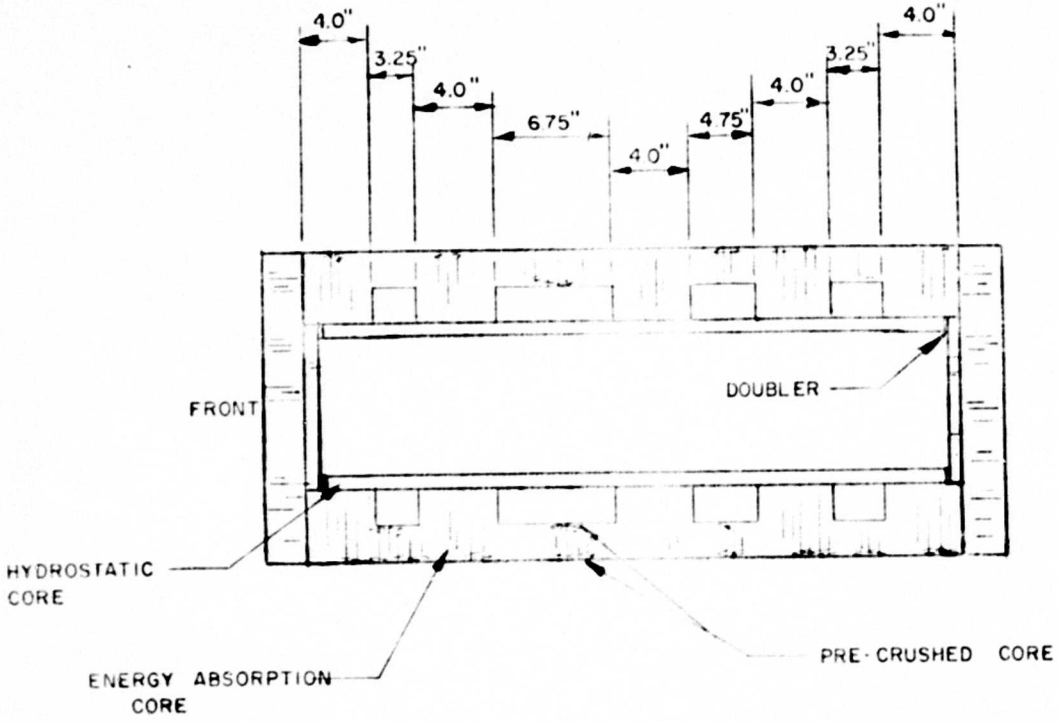

SECTION

CASE HXL-3-477 ENERGY ABSORPTION CORE FIGURE 1

NOT TO SCALE

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TABLE 1

SUMMARY OF VIBRATION TEST RESULTS ON CASE HXL-3-477

FREQUENCY (CPS)	INPUT (g's)	OUTPUT PEAK ACCELERATIONS (g's)		
		ACCEL.#1 *	ACCEL.#2 *	ACCEL.#3 *
VIBRATION ALONG LONGITUDINAL AXIS				
5	-	-	-	22
26	5	-	-	26
135	5	-	-	50
244	5	-	-	9
VIBRATION ALONG VERTICAL AXIS				
21	2	4.3	-	-
35	2	7.0	5.1	2.8
45	2	-	-	8.4
58	5	8.1	10	-
110	5	11.0	-	-
127	5	-	30	-
128	5	-	-	58
195	5	-	50	-
205	5	-	-	28

* Accelerometers were located as shown below. The same instrumentation was used for both tests. The arrows indicate the direction along which each accelerometer measures g values.

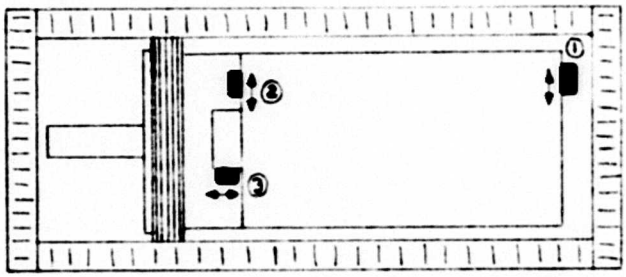

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TABLE 2

SUMMARY OF DROP TESTS ON CASE HXL-3-477

Drop Weight: 205.3 lbs.
Drop Height: 36 inches

See Figure 2 of Progress Report #4 for explanation of Peak Deceleration and Duration.

Drop	Location of Drop	Peak Deceleration (g)&Duration(mil.sec.)						Deformation (inches)	Remarks
		Maximum		2nd Highest		3rd Highest			
		g	t	g	t	g	t		
End	Rear End Cap	79	6	75.4	5	36.5	7	Bottomed out	Caused leakage in hydrostatic cylinder
Flat	Position #1	73.6	2	79.2	5	34.6	8	1.2" with width of 10" at front end; 1.6" with width of 10.5" at rear end.	
Flat	Position #2 (90° from Pos. #1)	41.7	5	33.4				1.3" with width of 10" at front end; 1.6" with width of 10.5" at rear end.	The maximum peak appeared twice.
Edge	Front End	30.8	4	26.7	2			Front cap bottomed out; rear end of cylinder had 1" with width of 9".	a) g values shown are perpendicular to longitudinal axis of case. b) Accerometer was 25° with respect to longitudinal axis of cylinder. c) The hydrostatic cylinder was damaged and caused leakage. d) Drop angle = 50.8° to horizontal. e) Drop height was 36" from the dropping edge. f) 2nd high peak appeared twice.

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REFERENCE: 6065

CONTRACT NO. DA-04-200-AMC-477(A)
JUNE 16, 1964

ATTACHMENT #1

STATEMENT OF MAN HOURS EXPENDED - MAY 1964

	MAN HOURS
Engineering:	
Sr. Professional	3.0
Professional	203.5
Drafting: Technician	125.0
Fabrication and Testing: Technician	
Other:	
Clerical	24.0
TOTAL HOURS EXPENDED:	355.5

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Reference: 6055

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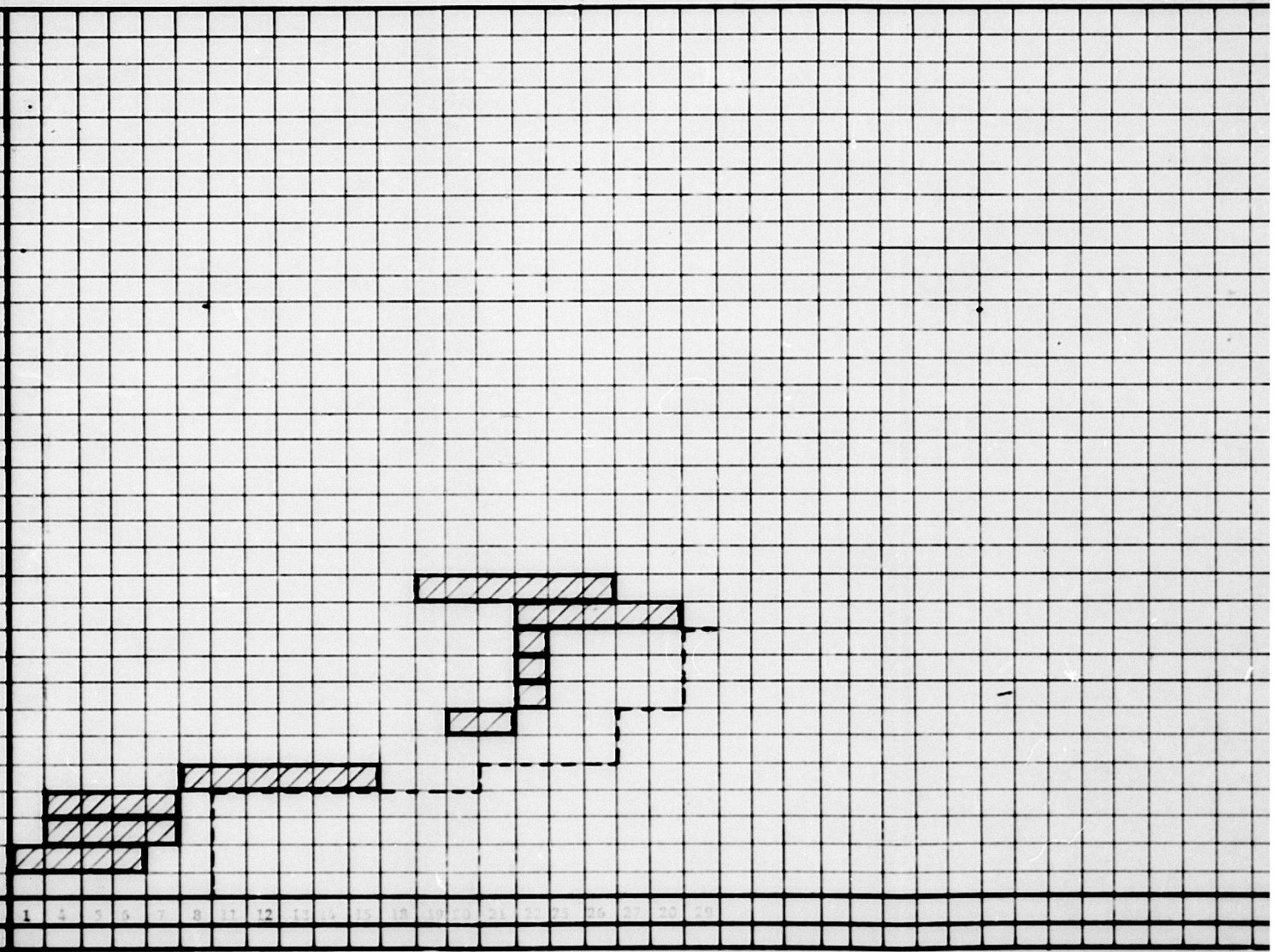
ATTACHMENT #2
CURRENT PROGRESS
MAY 1964



...BLIQUE CONVERENCE
c. Analysis
d. Edge Drop
e. Flat Drop
b. Sud Drop
g. Vibration
...ESTING AT BERKELEY (HXL-3-477)
...ASE FABRICATION (HXL-3-477)
...ATERIAL PROCUREMENT
b. Revise Engineering Drawings
a. Design Modification
...ESIGN MODIFICATION

1 4 5 6 7 8 11 12 13 14 15 18 19 20 21 27 28 26 27 29 30

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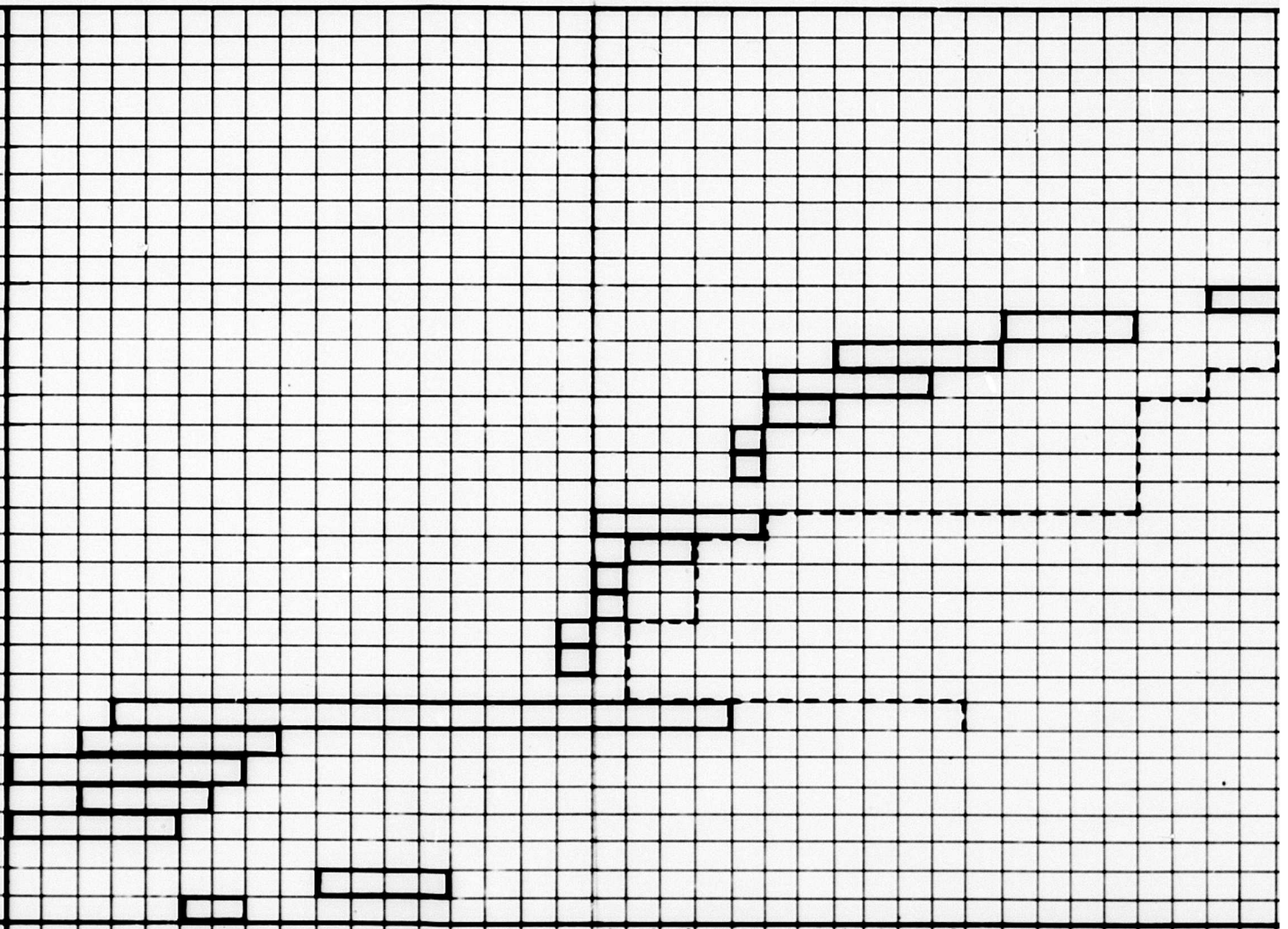

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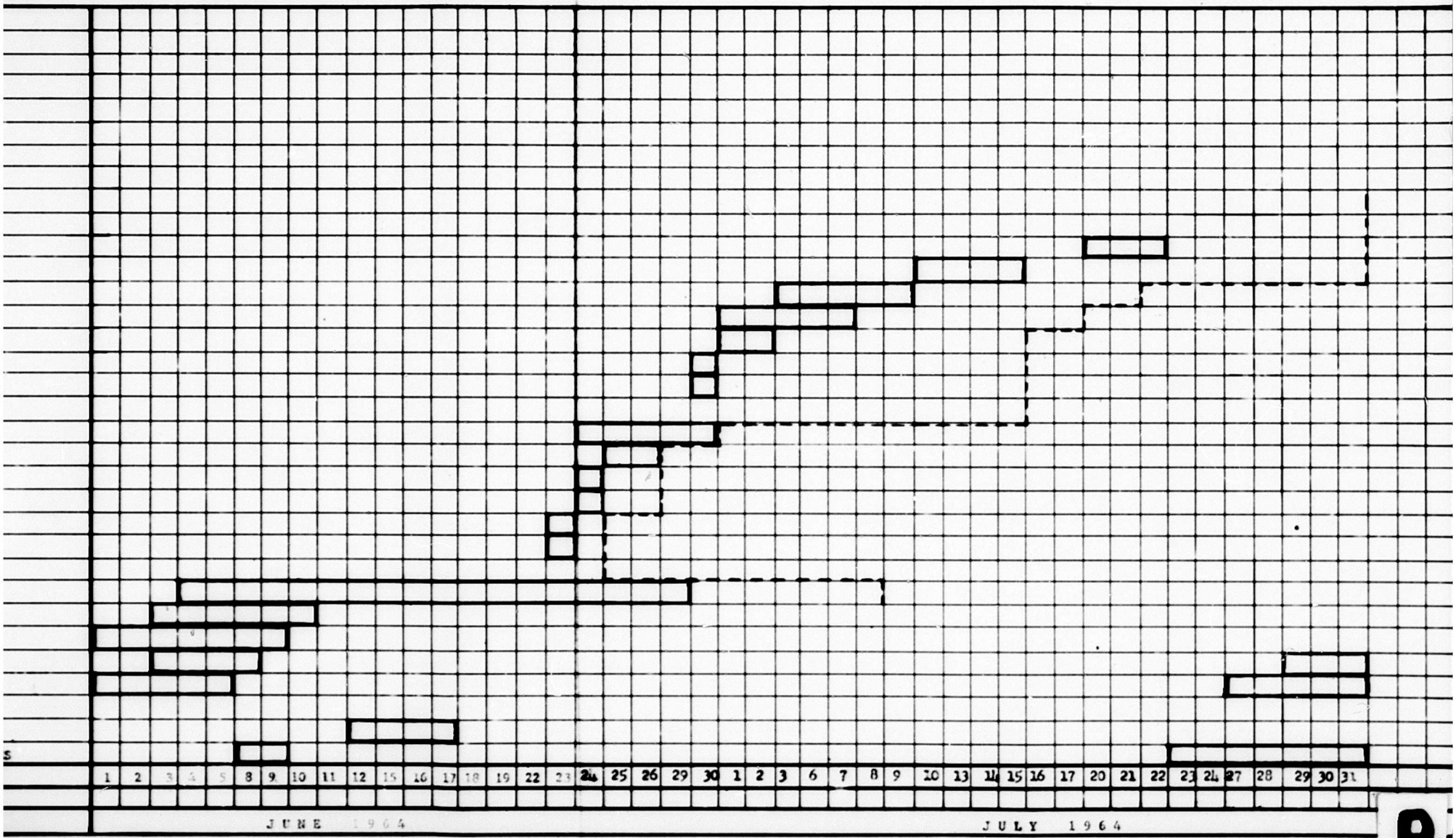
ATTACHMENT #3
PROGRAM OF ENSUING ACTIVITIES
JUNE AND JULY 1964



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